

FIRE SAFETY AND SECURITY IN SCHOOLS

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Abstract

This report examines the historical and present situation in New Zealand regarding school fires and arson. The Ministry of Education has been installing combined security and smoke detection alarm system in schools since 1991 as a measure to protect schools from fire and arson. The costs and benefits of this system are compared to an automatic sprinkler system.

The security and smoke detection alarm system provides early warning in the event of a fire. Since the installation of these systems there has been a reduction in the cost of fires. This system is relatively inexpensive compared to an automatic sprinkler system.

An automatic sprinkler system provides not only a warning device but also a suppression mechanism that acts to extinguish or control the fire while it is still very small. Water is applied directly to the base of the fire resulting in very little fire damage compared to the major losses in a building protected with a security and smoke alarm detection system.

The best strategy to further reduce fire losses in New Zealand schools is to progressively install automatic sprinkler systems in new and existing buildings.

1. Introduction

The objective of this report is to assess the costs and effectiveness of fire sprinklers in school buildings, compared with combined fire detectors and security alarms.

There is a need to protect schools, as millions of dollars is spent every year repairing or replacing schools that have been damaged or destroyed by fire. The Ministry of Education currently has a policy of installing security alarms linked with smoke detectors into schools as a security and fire reducing measure. The policy was introduced to reduce the incidence of arson fires and the cost of fires.

The use of smoke detectors as a fire protection measure is appropriate when it comes to life protection. Smoke detectors notify that there is a fire but do nothing towards suppressing it. The majority of fires in schools occur at night and during weekends, when the buildings are unoccupied.

The ultimate form of property protection is a sprinkler system. A sprinkler system will detect the presence of a fire, send out an alarm, and suppress or control the fire while the Fire Service is en route. The initial outlay for sprinkler fire protection is costly. It is often given a lower priority than it should have, due to expense concerns and ignorance of the benefits of such a system.

2. Information Review

The use of the University of Canterbury library database and Firedoc (a Nist web site) essentially made up the components of the information review. The keywords that were used were school, fire, and arson. Information was also gathered from official sources and contacts made during the research.

2.1 School Fires

Statistics and information regarding school fires in New Zealand are available on the Fire Incident Reporting System (FIRS) of the New Zealand Fire Service. The database is large and consists of every incident that the Fire Service attends including fires, rescues, hazardous incidents and false alarms.

The Ministry of Education has statistics on the number of school fires and on the cost of damage due to fires. It is important to note that the Fire Service and the Ministry of Education statistics may not be the same. The Fire Service records all incidents of fire, which may include rubbish or scrub fires. Fires that are controlled and do not cause any damage will occur on the Fire Service records but not on the Ministry of Education records. It is also important to note that both the Ministry of Education and the Fire Service records are based on a financial year, from 1st July to 30th June. The data used in this report is based on this format.

New Zealand statistical information is also available in Cropp (1992) and NZFS (1998). Statistical information on the situation in the United States is available in Endthoff (1991), and Hall (1998).

2.2 School Arson

The Ministry of Education has records of the cost of arson fires compared to the total cost of all school fires, from 1988/1989 onwards. This recording system was started after an outbreak of arson fires in the mid-1980s. These statistics are needed to study the effectiveness of preventative measures that have been installed in schools and to monitor the situation. Statistics are also used in risk analysis to determine regions and individual schools that are high risk, assisting in the allocation of funds for the protection systems.

It is possible to search the Fire Service (FIRS) system for records of school fires where the cause is listed as “incendiary”. These are the fires that were deliberately lit or those where evidence supports that they could have been deliberately lit.

A report by the Institute of Criminology for the Ministry of Education on school arson (Pratt, Young, and Hamilton, 1992) investigates the extent and trends of the arson problem in New Zealand. It also looks into the types of people involved and the schools role in arson and vandalism. It examines school interaction with the community and the effect this has on arson, as well as specific crime prevention strategies that can be provided to prevent or reduce the problem.

The British magazine Fire Prevention Journal regularly features articles on school fires and school arson. These articles include case studies on school fires and arson, costs of arson and prevention methods (Fire Prevention 1974-1998; Jerome, 1991). It provides useful statistics (Scoones, 1992-1997; Vyse, 1998), information on new ways to combat arson and many other new ideas (Woodall, 1989; Myers, 1991; Woodward, 1991; Leech, 1992a, Brown, 1997).

Other sources of information on school arson and prevention of arson can be found in Fire Prevention Association (1989), Ackland (1994), Goyer (1996), NFPA (1996), Stokes (1997) and Koffel (1998).

2.3 Security and Smoke Detection Alarm Systems

The majority of information available on security and smoke detection alarm systems is through security experts in industry. This report drew on two main sources:

- Mr Trevor Tozer, National Security Coordinator for the Ministry of Education. He devised the dual alarm system and helped write the specification documents for the supply and installation of this system in schools.
- Mr Mike Kyne, a security management consultant. Mr Kyne is also a consultant for the Ministry and is investigating problems with the dual alarm system.

International information regarding security systems and fire systems can be found in numerous articles (Harris, 1987; Middleton, 1988; Melhuish, 1988; Sullivan, 1998; Wilton, 1988; Shaw et al, 1993a and 1993b and Reed, 1997).

2.4 Sprinkler Systems

Statistical information on the performance and technical aspects of sprinklers in New Zealand and Australia over the last century is found in Marryatt (1988).

Mr Russell Gregory, a fire engineer with Wormalds Ltd, was consulted about sprinkler systems. He has numerous years experience in the sprinkler industry in New Zealand and is considered an expert in the sprinkler industry.

A New Zealand publication regarding sprinkler systems is Fire Sprinkler Technology: Costs and Benefits (Quigley et al, 1989). The study looks at the potential of mandatory use of sprinklers as a potential technique to reduce the New Zealand Fire Service

expenditure. It also analyses the costs and benefits of the wider use of sprinklers and whether this would have national and community benefits.

Fire Prevention journal also features articles on sprinklers. These cover all facets of sprinkler systems including new technologies and potential uses as well as dealing with misconceptions of sprinkler performance (Hattan, 1992; Leech, 1992c; Boyt, 1994; Gibbon, 1994; Powers, 1995; Stephens, 1995). They have had various articles that recommend the use of sprinklers as ideal fire protection for use in schools.

The National Fire Protection Association (NFPA) often publishes documents on general fire data from the United States. Two of their more recent publications detail both sprinkler systems (Hall, 1996) and fire detectors (Ahrens, 1997).

There are numerous other publications that deal with school arson, sprinklers and case studies (VanderTouw, 1976; Mc Bride, 1978; Manning, 1978; Tamin, 1992; Leech, 1992b; Williams, 1994).

2.5 Ministry of Education Resources

Several Ministry of Education personnel have provided useful information including:

- Brian Mitchell, Implementation Manager, Property Implementation, Property Management Group
- John Kelly, Property Analyst, Property Implementation, Property Management Group
- Earl Fogarty, consultant to the Ministry of Education
- Trevor Tozer, National Security Coordinator

The Ministry of Education documents reviewed include:

- A report by Works Consultancy Services estimating the cost involved with the installation of sprinklers in schools (Shears, 1994).

- A submission to the minister relating to the above document with the ministries recommendations (Simpson, 1994).
- A report on Fire and Design of Education Buildings (Department of Education, 1982).
- Specification Document for the Supply and Installation of a Security and Smoke Detection Alarm System for the Ministry of Education (Ministry of Education, 1998).
- Policy Statement 1996/13: Sprinkler Systems in Schools (Ministry of Education, 1996).

3. School fires

There are approximately 2,500 schools in New Zealand, including primary, intermediate and secondary schools. In New Zealand to date about 900 schools are protected with the dual alarm systems. Only a few schools have a sprinkler system.

3.1 New Zealand

New Zealand statistics from the middle of the 1980's to 1990 show a dramatic increase in the number of school fires. Table 3.1 is from the New Zealand Fire Service booklet on school fires (Cropp, 1992). It shows the major increase in school fires from 189 incidents in 1986 to 322 in 1990, an increase of 75%. The data in Table 3.1 is based on the FIRS database of the New Zealand Fire Service, and does not include exposure fires or false alarms.

Year	1986	1987	1988	1989	1990
No. school fires	189	231	323	311	332
Total fires	18906	19373	21130	18798	18808
% in schools	1.0	1.2	1.5	1.7	1.8
Ratio of school fires to number of schools	1:15.1	1:12.4	1:8.9	1:9.2	1:8.9

Table 3.1 – School Fires

The developing trend indicates that at the rate at which school fires were increasing, there would be one fire in every five schools by 1995 (Cropp, 1992). When Cropp's report was released it created concerns about the school fire situation in New Zealand. The Ministry of Education began investigating the number of school fires along with the increasing

cost of such fires. This was the reason for the creation of a national security coordinator and the consequential installation of security and smoke alarm systems.

Information has been accumulated from the FIRS database for the years following the Fire Service publication, in order to provide more up to date information on the trends for school fires. The database was searched in Microsoft Access. This process involved making a series of queries. The first query was to isolate the relevant information from the database tables. The second query was on the results of the first query and was to group and count the information. The information was grouped by incident code to count the number of each type of fire.

The search was initiated by isolating the year of interest. All the incidents that involve fire (as opposed to rescue, false alarms etc) are gathered together by searching in the “incident type” database field. A four number code beginning with the digit 1 depicts a fire incident, often referred to as a primary incident.

All exposure fires were eliminated from the data. Exposure fires are those that started from the original fire incident and needed to be removed to avoid double counting the same fire. A zero on the end of the incident code indicated that the record was that of the first event, fire number one from the event.

School fires were then searched for under the field of “complex code”, 21 and 22 represent educational properties. This search provided the number of school fires for a particular year.

Of particular interest are fires where the cause is incendiary. Incendiary fires are those where evidence leads investigators to conclude that the fire was deliberately lit. The cause of fire is identified in the “supposed cause” field of the database. This search results in the number of school fires that were the result of arson or suspected arson attacks.

All of these steps were run as part of a single query. In Microsoft Access a second query must be run to collate the data.

Data was not available on the University of Canterbury network for the FIRS information beyond 1st July 1995. The Fire Service kindly collated the required information.

In Table 3.2 are the up to date school fire statistics.

Year	1990/1	1991/2	1992/3	1993/4	1994/5	1995/6	1996/7	1997/8
Number of school fires	423	388	454	506	522	404	562	604
Total number of fires	19920	19171	18833	20627	21648	17880	20454	24139
% in schools	2.1	2.0	2.4	2.5	2.4	2.3	2.7	2.5

Table 3.2 School Fires in New Zealand

The data shows that:

- the total number of fires is increasing
- the number of school fires is increasing (shown in Figure 3.1)
- the percentage of all fires that involve schools is increasing

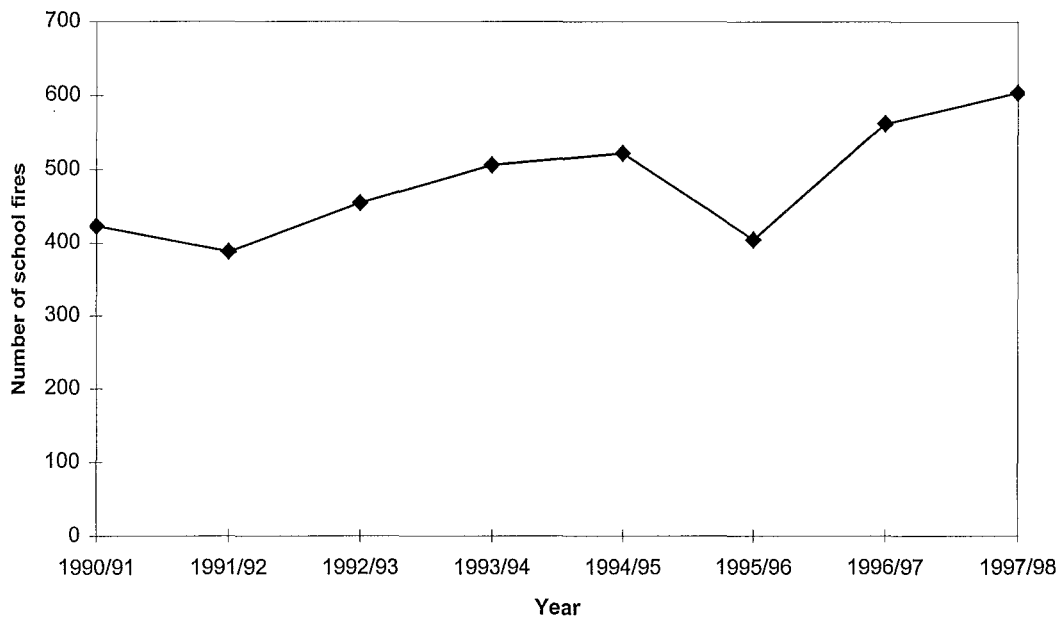


Figure 3.1- School fires in New Zealand (FIRS)

The overall conclusion is that the trend shows school fires are still on the increase. This is despite any measures that have been installed in schools to reduce the instances of fire. In 1991, Cropp predicted that one in every five schools would have a fire incident by 1995. Assuming the total number of schools is 2,500, then for the 1995/1996 year there was one fire in every 6.2 schools, indicating that the rate of increase of fires had dropped. However in 1997/1998 year there were 604 incidents, one fire for every 4.2 schools, a higher rate than Cropp predicted.

The school fire problem in New Zealand appears to be steadily increasing, although in the last few years the rate of increase has dropped. With approximately 2.5% of all fire incidents in schools and only 2500 schools in New Zealand this is obviously a serious on going problem.

School fires are summarised in Table 3.3, according to the type of fire that occurred.

Year	% Structure fires	%Mobile fires	%Vegetation fires	%Chemical and gas	%Miscellaneous – rubbish	Total
1989/0	49	3	14	0	34	100
1990/1	35	3	16	0	46	100
1991/2	34	3	14	0	49	100
1992/3	31	2	17	1	49	100
1993/4	36	2	19	1	42	100
1994/5	29	4	24	1	43	100
1995/6	16	4	26	1	52	100
1996/7	34	4	20	1	41	100
1997/8	32	3	21	0	43	100

Table 3.3 - New Zealand School Fires Incident Types

These statistics show an interesting trend, that there has been a decline in the percentage of school fires involving the school structure. There has been a significant increase in the percentage of school fires that involve vegetation and also an increase in the fires that are miscellaneous. Miscellaneous fires include outside rubbish fires, bonfires, barbecue fires and fires that have minimal value and were caused by an incendiary device.

Statistics from the Ministry of Education are shown in Table 3.4 and also in Figures 3.2 and 3.3. They include the number of school fires and the cost of the damage incurred.

The Ministry of Education fire statistics are quite different from those of the Fire Service. Their statistics show far fewer fire incidents, however the records will only include fires that are reported to them and that required money for the schools to repair the damage.

Year	Number of school fires	Estimated cost \$M
1988/9	95	9.4
1989/0	71	23.4
1990/1	74	7.0
1991/2	83	6.7
1992/3	66	5.6
1993/4	76	7.4
1994/5	69	4.3
1995/6	63	3.4
1996/7	70	5.1
1997/8	68	2.9

Table 3.4 - Ministry of Education statistics

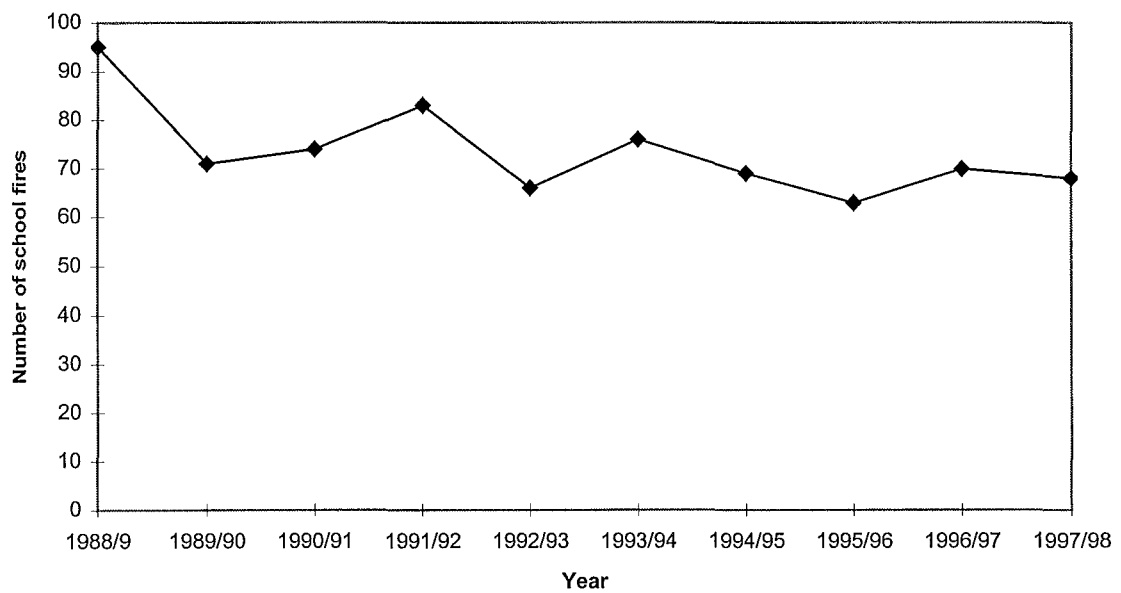


Figure 3.2- School fires in New Zealand (Ministry of Education)

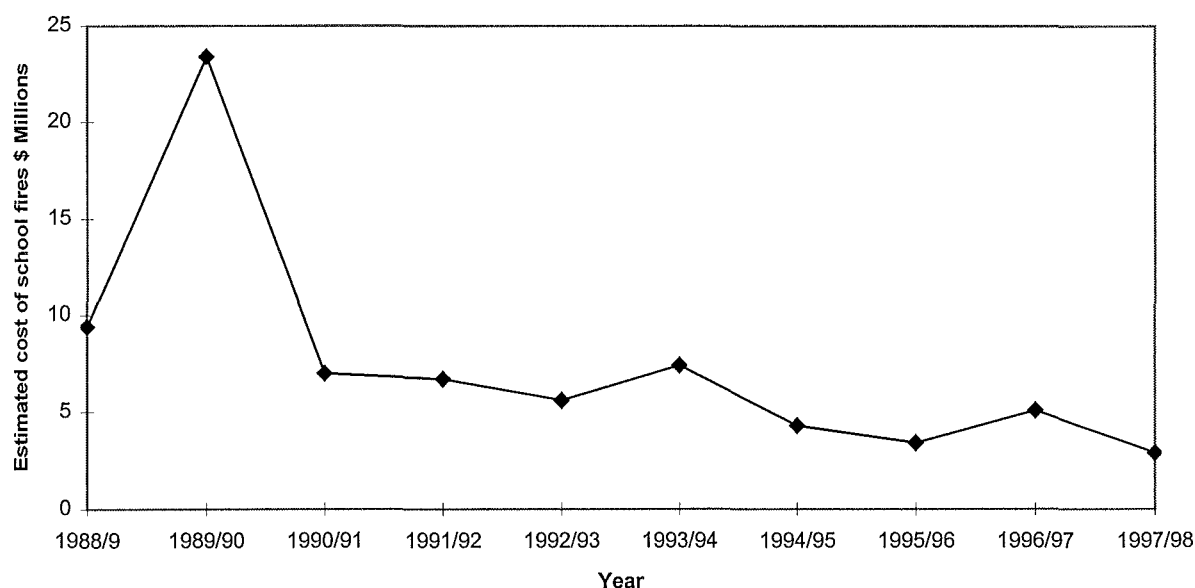


Figure 3.3- Cost of school fires in New Zealand (Ministry of Education)

The year 1989/90 has a huge fire loss compared with the others. It can be considered an anomaly due to an unusually large number of arson fires and a large fire at Avondale College in Auckland. This single fire alone resulted in \$8 million in damage.

The number of school fires has remained steady over the years at approximately 60 to 70 fire incidents. The only significant trend is in the amount of all losses due to fire. There is a significant reduction in the cost of fires. This is supported in the trend shown in table 3.3, where less fires are involving structural parts of the school. There are a number of factors that could lead to this result. One major factor could be the Ministry of Education's progressive installation of dual alarm systems in high-risk schools, since 1991. The reduction is possibly due to the smoke detectors providing early warning, which reduces the resulting damage.

3.2 School arson

Table 3.5 and Figure 3.4 are the result of the search of the FIRS database regarding incendiary school fires.

Year	Incendiary fires in schools	School fires	% Arson
1989/0	137	370	37
1990/1	144	423	34
1991/2	138	388	36
1992/3	194	454	43
1993/4	250	506	50
1994/5	309	522	59
1995/6	263	404	65
1996/7	327	562	58
1997/8	359	604	59

Table 3.5-New Zealand Fire Service Incendiary Statistics

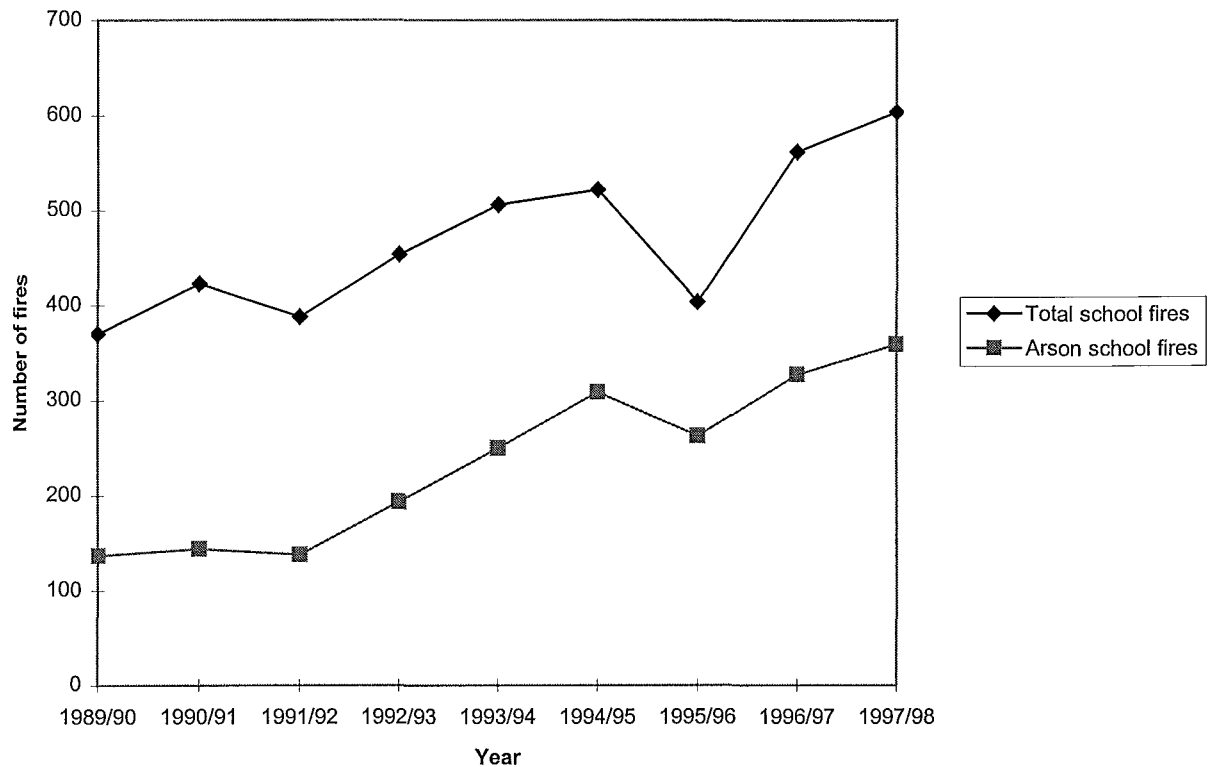


Figure 3.4 - New Zealand Fire Service Statistics

There was an increase in the percentage of school fires that were incendiary in nature over the period of 1989-1998. The number of suspicious fires increased dramatically over the period from 37 % of all the school fires to a peak in 1995/6 of 65%. This is a discouraging trend.

Statistics on arson from the Ministry of Education are in Table 3.6 and also in Figure 3.5.

Year	Arson Fires	School Fires	% Arson	\$M arson
1989/0	61	71	86	15.8
1990/1	49	74	66	4.9
1991/2	51	83	62	4.5
1992/3	45	66	68	2.8
1993/4	51	76	67	6.4
1994/5	44	69	63	3.9
1995/6	37	63	59	1.8
1996/7	40	70	57	2.4
1997/8	47	68	69	2.7

Table 3.6 - Ministry of Education Arson Statistics

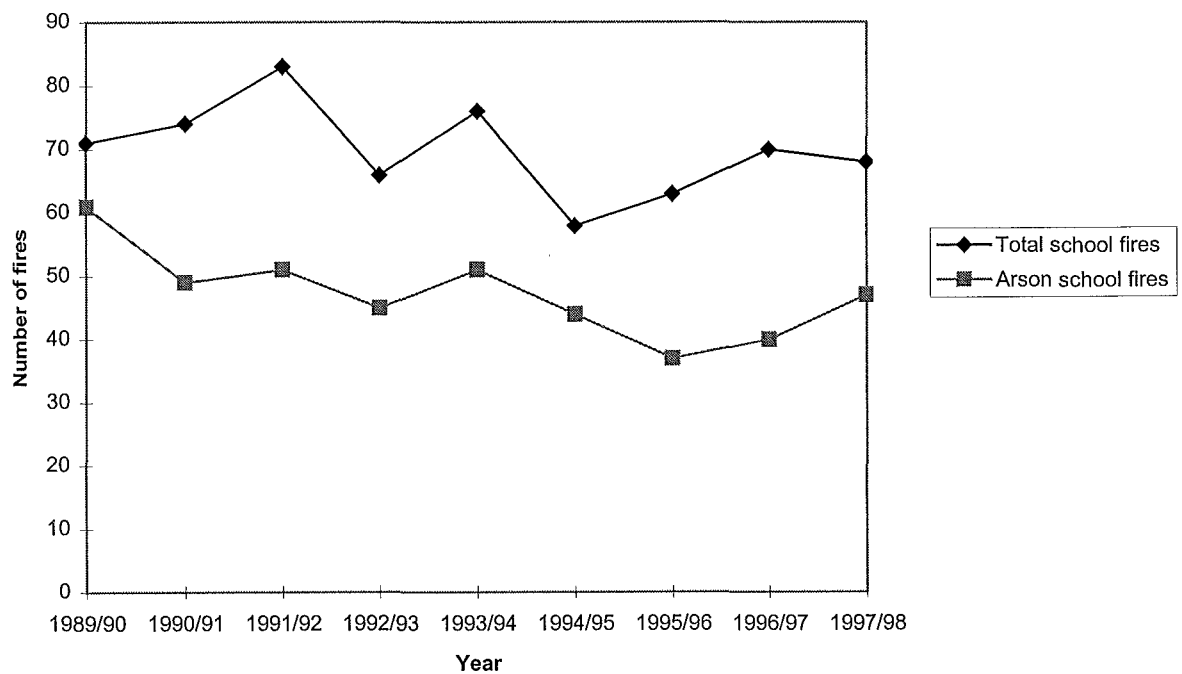


Figure 3.5- Ministry of Education fire statistics

This shows that the percentage of all school fires that are arson has remained fairly constant at approximately 60-70% in the last eight years. This is significantly lower than the 86% experienced in the year 1989/90. The cost of arson fires has dropped significantly in the last eight years. This could be a direct result of the installation of alarms.

The percentage of fires that are arson related is higher in the Ministry of Education statistics than Fire Service statistics. This is possibly because the fires that cause the damage are arson related.

A possible reason that schools are targets for vandalism and arson is given by a Municipal Mutual Insurance limited in the UK, a firm that specialises in insuring public authorities (Leech, 1992a). For various reasons anti-social and criminal activities tend to be aimed at the softest available target. In the UK this tends to be schools, especially since they have not been designed to prevent any kind of criminal activity and lack fire protection.

New Zealand schools are often based on those from the UK and are often placed back from the street front on rear sections. Buildings have been built with alcoves, porches and other nooks and crannies that are ideal for illegal activities to take place out of view. These factors combine to make schools easy targets.

A report published by the Institute of Criminology for the Ministry of Education on school arson (Pratt et al, 1992) investigates the extent of the problem in New Zealand. It examines the trends, the kinds of people involved, the role of the school and specific strategies to prevent the problem.

It is based on police case files, from 31 of the 43 cases of school arson, from the period of July 1991 to June 1992. The report relies on interviews with key education, police and

Fire Service personnel. The cases involved 8 arsonists that were from 13 to 19 years of age.

They found that incidents of school arson in New Zealand have the following features:

- larger urban areas have a greater rate of school arson than the national average
- more likely to occur in low socio-economic areas
- mostly committed in night or evening
- storage areas, art rooms and sports gear are more at risk than other areas
- more likely in vacation periods
- accelerants are rarely used
- 10 of the 31 fires took hold despite intruder alarms - alarm systems do not prevent fires.

The arsonists were all found to have come from low socio-economic, disturbed family backgrounds with severe social disadvantage and educational failure. Schools were chosen for arson not necessarily for vengeance against the school but because they were a public target and used to vent feelings against the system, education or anything else.

It was found that factors that are extrinsic to the management of the school such as the architectural design, environmental setting, and socio-economic status of the neighbourhood might affect the risk that it will be the target of arson.

Poyner (from Pratt et al, 1992), indicates that there are several variables that are important to protect a school against arson:

- good maintenance
- situated in a busy area
- unobstructed view from the street

Hope (from Pratt et al, 1992) says sprawling, modern schools are more attractive to arsonists. They are more likely to have outlying areas, grassed areas hidden from view from the street and buildings with varying height or lots of glass.

According to Pratt, the Ministry of Education had installed intruder alarms into the top 1/3 of schools most at risk of arson at the time of the report. Sloane Risk Management, in Pratt et al (1992), believes that there has been reduction in fire loss claims and that the system is efficient in reducing the frequency and cost of claims for the building and contents.

It is cautioned that the alarm systems must be appropriate for use in schools and that they are properly installed (Pratt et al, 1992). Out of the study of police files 2 of the schools had faulty alarms, while 10 had alarms but still experienced a fire. It is important to be aware that installing an alarm system is not going to be totally effective in fighting arson.

In conclusion (Pratt et al, 1992) there are various things that can help in preventing arson:

- the location of the school needs to be in public view, with night lighting and good upkeep of the school
- surveillance of the school after hours
- access prevented by minimising access points and good locks on doors and windows
- intruder alarms to detect access
- fire protection by using fireproof materials and removing combustible materials from the exterior of the building.

A consultant engineer in the UK suggests that out of all the precautions that can be taken against an arson attack, automatic sprinkler protection is probably the most effective (Myers, 1991). Attacks on property usually occur when people are not present. The only way to ensure minimum damage and disruption is to have a sprinkler system.

3.3 International comparisons

The Fire Prevention journal runs an article every year on serious fires in educational establishments in Britain. They consider serious fires to be those causing fatalities or losses in excess of £50,000. Table 3.7 shows the latest data, for the years 1992-1996.

Year	1992	1993	1994	1995	1996
Number of serious fires in education	105	51	42	50	47
Total losses due to education fires £M	36.2	22.5	17.8	29.1	28.9
Total number of all serious fires	950	682	648	672	497
Number of serious education fires as a % of all serious fires	11.1	7.5	6.5	7.4	9.5

Table 3.7 - British School Fire Information

The percentage of fires that are in education buildings is a lot higher than New Zealand statistics, about 10% compared to our 2.5%. As is the case in New Zealand, the cost of educational fires is measured in the millions of dollars.

In a US study (Hall, 1996) it was found that sprinklers reduced the average fire loss. Table 3.8 is an abbreviated version of the results from Hall (1996). It shows that in educational buildings the use of sprinklers reduced the cost of property damage by 67%. This study data was from average fire losses per fire in the United States using annual averages from 1985-1994.

Average Direct Property Damage per Fire			
Property Use	Without automatic suppression equipment	With automatic suppression equipment	Percent Reduction
Educational Properties	\$13,200	\$4,400	67%

Table 3.8 - US Property Damage from Hall, 1996

This shows a significant reduction in fire losses. It is interesting to note that educational properties had the highest reductions out of all property types that have sprinklers.

From Hall (1998) a study using United States fire data from 1991 to 1995, educational property fires were 5.1% of all non-residential structure fires, and featured 3.4% of associated property damage. Arson dominates the fire and property damage for educational buildings, with 47.7% of the fires being incendiary or suspected incendiary. The next major causes are 8.3% unknown and 7.9% electrical faults. The total average property damage over the period of this study, was \$US 95.7 Million per annum.

In the US schools are old and constructed of outdated building technology that provides little in the way of fire protection (Endthoff, 1991). Buildings are generally honey combed with concealed and combustible spaces, which allows fire to spread easily from one space to another undetected. New schools are being constructed with less concern for fire safety than common hotels. They provide more security from theft, vandalism, or unauthorised entry than they provide for detection and suppression of fire.

The situation in the United States seems very similar to that in New Zealand.

4. Ministry of Education

In New Zealand the Ministry of Education set the policy and requirements for the standard of schools and their buildings. The Ministry of Education has several documents that concern fire protection. The documents are:

- Fire and the Design of Education Buildings (Department of Education, 1982)
- A report by Works Consultancy Services (Shears, 1994)
- A submission to the minister with the ministries recommendation regarding sprinklers (Simpson, 1994).
- A Policy Statement 1996/13: Sprinkler Systems in Schools (Ministry of Education, 1996).

4.1 Insurance

Marsh and McLennan and Lloyd Syndicates of London insure all schools in New Zealand for a combined replacement value of approximately \$7 billion. There are basically three types of insurance policies:

- Catastrophic loss policy (buildings)
- Contracts works policy
- Contents policy

The Ministry of Education covers the first two and schools can contribute towards the contents insurance or take out their own policy.

The maximum probable loss in an earthquake and fire situation is expected to be \$250 million. Most of the loss is expected in the Wellington area

4.2 Fire Design

The document “Fire and the Design of Education Buildings” (Department of Education, 1982) is an architectural standard which was produced by the Ministry of Education in 1982. It is a prescriptive document that states the exact design requirements of education buildings. Earl Fogarty, a consultant for the Ministry of Education, is currently reviewing the document, because it does not refer to the current Building Act of 1991. Mr Fogarty’s job is to assess whether the document is necessary, or whether it may be more appropriate in a modified form. Other options could be that schools should comply entirely with the Building Act, or perhaps a modified version of the acceptable solution could be used rather than fixing the old document.

The document is the design requirement for pre-schools, primary, intermediate, secondary schools, teachers colleges, technical institutes, universities, and hostels. The Director-General of Education can only give dispensation from any of the requirements. The objective is to ensure that schools provide adequate safety standards for pupils and staff.

The document states that “in general the design requirements of NZS1900 Chapter 5 in conjunction with the supplementary measures in this code shall be met”(NZS 1900 Chapter 5 was the building code at the time this document was written). There is constant reference to NZS1900 Chapter 5 and the standard tends to make additional requirements on the designer above those required in the code.

The New Zealand Building Code is a performance-based code that enables designers to take a sensible engineering approach to the design of fire safety systems (Buchanan, 1999). A performance-based code requires performance criteria to be met and allows a system to be designed to suit the individual building. It enables systems to be designed for unique situations and enables a design that is the best possible solution.

The Ministry of Education standard “Fire and the design of education buildings” imposes higher building and safety standards than those required by the New Zealand Building Code (Simpson, 1994). All new or extensively remodelled buildings will be to this standard. They will include fire protection and safety components such as compartmentalisation (every 1,000m²), fire doors, fire rated walls and fire breaks within the roof structure.

The Building Act and Building Code are focussed on protection of life, the warning of occupants that a fire is present and providing suitable escape routes for safe evacuation. The focus is entirely on people and ensuring that the burning building does not affect anyone else's property. It is essential that occupants in a building are safe from the fire. However if the building has a specific function property protection is also important. This can save all sorts of indirect costs that are associated with fire.

Arson is a major threat to schools. It most often occurs at night when buildings are likely to be deserted, so that no manual alarm or quick thinking actions can alert or attack a fire. At this stage a detection system and an automatic sprinkler system could provide the essential elements to greatly reduce the affect of the fire on the school. The Ministry of Education should focus any possible future policy changes to include facilities for property protection as well as the protection of life.

Some members of the fire engineering industry are of the opinion that in the case of design in schools, the fire protection standards and requirements are not always appropriate. The cost involved to meet these standards makes the systems unaffordable for schools. Fire engineers would be able to install more systems into schools if the requirements would allow alternatives that had been engineered for a particular situation, which in many cases would allow a less expensive installation.

4.3 Report on cost of installing sprinklers

In the 1993/4 financial year the Minister of Education requested a report regarding the feasibility of installing sprinklers in schools. This program was proposed to be linked to the scheme of progressive installation of security and smoke alarms in all schools.

The report was prepared by the Ministry by Works Consultancy Services (Shears, 1994) and a copy was obtained through personal correspondence with Brian Mitchell, Implementation Manager of the Property Management Group at the Ministry of Education.

Works Consultancy Services submitted the report to the Ministry of Education in February 1994 with an estimation of the cost involved with installing sprinkler protection in schools. The study was produced assuming that there were 282 secondary schools with average school roles of 1200 students. It was also assumed that there were 2134 primary and intermediate schools with roles of 350-400 students. The study gave the ministry cost estimates on four different scenarios.

Option A was the first scenario, involving a system with complete compliance to the New Zealand Building Code and with the sprinkler code NZS4541. This would provide schools with total protection for all buildings and provide a direct connection from the alarms to the New Zealand Fire Service. The comment by Works Consultancy was that in certain buildings the cost of the fire protection would be equivalent to the total capital cost of the building. There was concern expressed that in some buildings sprinklers would be placed in exposed areas like a corridor where they would be susceptible to vandalism. There was also concern that the testing and maintenance costs for this option would be high.

Option B is cheaper than option A, as it only provides protection in schools with a capital cost exceeding \$50,000. It excludes cheaper buildings and any transportable or minor

buildings more than 6m from other buildings. It indicates that this is partial protection of buildings and that the result of this is that the system may not comply with the building code or the sprinkler code. This will result in the system being unable to get a direct link to the Fire Service.

Option C is the 'engineered' solution. It is to provide total coverage to all school buildings using a mini valve set. The solution will therefore fail to comply with the building or sprinkler codes.

Option D is another engineered solution that provides only limited protection. Buildings with a construction cost of over \$50,000, excluding transportable and minor buildings over 6m from other buildings will be protected with a limited form of protection. This will be in the form of a mini valve set.

The mini valve set option:

- is an engineered system that assumes single head operation.
- operates from mains water pressure and only a limited number of heads are able to operate at once.
- also involves reducing the testing and maintenance costs.
- offers a building less protection and reliability than a standard sprinkler system.

The estimated costs of the options were:

Option	A	B	C	D
Cost \$ Million	\$146	\$112	\$117	\$88

There are many features of this proposal that create concerns. They are:

- vandalism concerns
- partial sprinkler systems
- mini valve sets

- reducing maintenance costs
- limiting the number of heads

Limiting of the number sprinkler heads that can operate at once is a concern, as a fire scenario may occur when many heads may be required. In Marryatt (1988), which gives the statistics of the last century of sprinklers in New Zealand and Australia only 65% of fires featured the activation of one sprinkler head. 35% of fires required the activation of two or more sprinkler heads. It is not appropriate to assume that only one sprinkler head will be satisfactory to control the fire.

Russell Gregory provided an explanation of the “mini valve” (minimum valve) set. It is a simplified version of the standard fire protection valve set and is hydraulically sound. It consists of a stop valve, check valve and a flow switch but does not have a hydraulic gong alarm or many of the testing and drainage facilities of the standard set.

This type of mini valve set is likely to cost approximately \$400. A standard fire protection version costs approximately \$4000. This is a significant saving, although the mini-valve set needs to be used with caution.

The mini valve set is made from equipment that is not usually used for the function of fire protection. In its regular other applications it is likely to be frequently used. Whereas these parts used as a part of a sprinkler system will be rarely used. Fire protection standard equipment is thoroughly certified, tested and checked and is specifically age tested so that it is able to sit idle for 20 years and then still perform the required task. This guarantee does not come with minimum valve sets, so this solution cannot be recommended as acceptable for use in schools.

4.4 Submission to the Minister

The submission given to the Minister of Education (Simpson, 1994) was based on the previous report from Works Consultancy Services (Shears, 1994). The submission was from the national property manager and included a summary of the situation in New Zealand. A copy of the submission was obtained through personal correspondence with Brian Mitchell, from the Ministry of Education.

Brian Mitchell stated that the recommendation in the submission was adopted as the Ministry policy, with the only change is being sprinklers are now installed in situ at all new schools, or when there is a major new building constructed in an existing school. That is if the installation of the sprinkler system is practical and cost effective.

4.4.1 Content

At the time of the study there were approximately 2400 state schools with a replacement value of \$5 Billion. Arson was a major problem that accounted for approximately 70% of all school fires.

The submission outlined the risk management strategy as of March 1994. The achievements listed in the submission were:

- a full time national security coordinator was appointed.
- in 1990/91 the national security programme was initiated, which involved the installation of intruder alarms and smoke detectors into schools and security patrols at schools perceived as high risk.
- \$3.5 million spent on systems in 370 schools, as research has shown that almost all school fires are caused by people who have gained unlawful entry into the schools first

- schools that had been protected with intruder/smoke detectors had experienced a significant reduction in incidents of burglary, vandalism, trespass and arson, with only two alarmed schools experiencing fires.
- since the introduction of the intruder/smoke systems the cost of arson fires had decreased.

The sprinkler system situation in New Zealand schools at the time of the submission was that:

- 21 schools in New Zealand had sprinkler systems installed
- eight of these were residential accommodation
- Ministry of Education had installed sprinklers only where specifically required by the New Zealand Building Code
- An example was Spotswood College, where the design had too many laboratories on one floor, so to overcome this problem sprinklers were installed. This enabled compliance with New Zealand Building Code, and also the Ministry's own standard.

Information provided to the Ministry about NZS4541, the sprinkler standard:

- When a building is required to have a sprinkler installation under the NZBC, the system is required to comply with NZS4541. However if the owner decides to install sprinklers without being required to, then the system does not need to comply.
- To comply with NZS4541, a connection to the Fire Service is required. Maximum effectiveness is achieved with a dedicated water supply, with specific flows and pressures and a minimum of 4 sprinkler heads per room.
- The submission stated that the Ministry did not need to comply with NZS4541 but needed to balance up the reduction in fire protection that would then be available.

Works Consultancy estimated that the installation of sprinkler systems in schools that comply with NZS4541 would cost \$146.5 Million plus on going testing and maintenance costs of \$3.9 million annually. This would cost about \$190,000 for a secondary school and \$40,000 for a primary school.

Cheaper options that involved non-compliance with NZS4541 would cost \$90-115million – these were custom design systems using low-pressure water supply and a minimum of 4 sprinkler heads per room. This would have cost \$140,000-\$175,000 for secondary schools and \$20,000-\$30,000 for primary schools.

It was suggested that should sprinklers be installed, schools that were high risk should be targeted. There was concern that installing sprinklers in high-risk schools will possible risk of vandalism, causing expensive water damage.

It was also pointed out that the intruder smoke alarm system had returned good results. One benefit stated was that because it is a dual system, if the intruder alarm was faulty then the smoke alarms would detect and send the alarm in the event of a fire. The expected response time of the Fire Service in urban areas is 3-5 minutes, which was considered fast enough to prevent significant damage.

It was pointed out that rural schools would be disadvantaged, as the expected response time of the Fire Service is much greater than urban areas. Installing sprinkler systems in rural areas would require the additional cost of storage water tanks for the water supply.

The cost of the dual alarm system was about \$30,000 per school. This is much cheaper than sprinklers, and the on going costs such as monitoring are lower. The alarm system could also detect unlawful entry and prevent burglary and vandalism as well as arson damage.

The Ministry considered that sprinklers should be addressed on a case by case basis, especially where an enhanced level of protection is required, such as laboratories.

The proposal put to the Minister was to:

- continue with the installation of dual alarm systems, while monitoring the effectiveness of the programme
- seek an improvement in the Ministry's risk rating with overseas underwriters when reviewing insurance cover.

The recommendations put to the Minister were to:

- approve continued dual alarm systems
- monitor effectiveness of dual alarm systems
- approve implementation of security systems budget
- agree that sprinklers are considered on case by case basis

4.4.2 Comments

The report seems to be biased against compliance with NZS4541. While this may be acceptable for certain installations, in cases where sprinkler protection is mandatory such installations must comply with either NZS4541 or NZBC. This is a pre-requisite for the Territorial Authority to grant consent. In cases where sprinkler protection is not mandatory but is used as a warning device for life safety purposes, it also needs to comply with NZS4541 or NZBC and have Territorial Authority consent. Once installed, the sprinklers need to be on the building compliance schedule and regularly tested and maintained. The major drawback for installing a non-complying system that was not mentioned was the acceptance of a system for insurance purposes. For a system to be accepted by the Insurance Council it needs to comply fully with NZS4541.

A rather misleading quote from the comment and comparison section is:

“Sprinklers may be effective in extinguishing fires before significant damage is done (depending on the design of the system) but they do not prevent a fire

starting. Intruder alarms detect unlawful entry and smoke detectors activate immediately a fire is ignited. In this context sprinklers activate at a ceiling temperature of 57 degrees Celsius whereas smoke detectors activate on the finest traces of smoke. The ideal protection system against fire is the installation of sprinklers complemented with intruder detection systems.”

The comment is simply misleading. Sprinklers will definitely (presuming they are designed properly) be effective in controlling or extinguishing a fire. The extent of damage is guaranteed to be less than the damage in a building with the same fire that is protected by an intruder alarm/ smoke detector system. The intruder/ smoke system may signal the presence of fire, but as there is no automatic extinguishment the fire will grow. Sprinklers attack the seat of the fire in its early stages, resulting in less damage. Statistics gathered by Marryatt (1988) show that historically sprinklers control 99.5% of all fires involving sprinkler activation.

Sprinklers are said to be obvious targets for vandalism that could lead to false alarms and expensive water damage. It was considered that vandalism would be likely in areas where ceiling heights are low and sprinkler heads are easily accessible. It would appear that sprinkler vandalism is not as likely as it was feared. University Hall, a hall of residence at Canterbury University has had a sprinkler system installed for three years. University Hall is often subject to vandalism attacks, both from residents and outsiders. There have been no incidents of false sprinkler activation due to vandalism.

The statement was made that the activation of an alarm will result in Fire Service attendance within 3-5 minutes (in urban areas). In the event of a fire, total or partial loss of a building and significant smoke damage is likely, even with a rapid response from the Fire Service. It is also felt that a response time of 3-5 minutes is unrealistic and is more likely to be 8-10 minutes. Since fire growth is exponential, a few extra minutes can mean the difference between a medium sized fire and a large fire. It is unrealistic to rely on the arrival of the fire service as the only active way of suppressing a fire in school buildings.

4.5 Policy Statement 1996/13 : Sprinkler Systems in Schools

This statement involves the standard to which sprinklers will be installed in schools (Ministry of Education, 1996). A copy of the statement is in appendix 1; it states specific requirements for:

- sprinklers in special schools
- sprinklers in residential units at schools
- sprinklers in new schools

4.5.1 Sprinklers in special schools

The Ministry is concerned about section 38 of the Building Act, which the Territorial Authority can decline building consent for alterations of buildings if they do not believe that the building complies with the Building Code for means of escape from a fire.

The Building Code requires sprinklers to be installed in situations where people are unable to reach a place of safety due to confinement, for mental or physical disabilities.

The policy is for any special school buildings to have sprinklers installed when being altered.

4.5.2 Sprinklers in residential units at schools

The alteration of any residential units requires the Ministry to install sprinkler systems under the Building Act in the situation when:

- an upper floor has more than 60 beds and when the building has a configuration that allows smoke to spread up from a lower floor

- the highest floor level in the building is 25 metres high or higher and has three or more floors

4.5.3 Sprinklers in new schools

New schools are to have sprinkler systems installed as they provide an enhanced level of protection, these will be in situ (at time of construction) rather than retro-fitting as this is the most cost effective method.

The sprinkler systems will be designed to the standard required by the Territorial Authority. They will comply with either NZS4541 or the New Zealand Building Code.

The Board of Trustees will cover the maintenance and operating costs of the system.

5. Fire and Fire Protection

When investigating the impacts that fire will have on buildings and people it is important to understand how fire behaves and the types of protection available. A few reference books that provide great information with relation to fire are:

- The SFPE Handbook of Fire Protection Engineers (SFPE & NFPA, 1995)
- An Introduction to Fire Dynamics (Drysdale, 1985)
- Fire Engineering Design Guide (Buchanan, 1994)

5.1 How fire behaves

Figure 5.1 is known as the fire triangle. In order for a fire to occur all three of the conditions must be present. The three elements of the fire triangle are heat, fuel and oxygen.

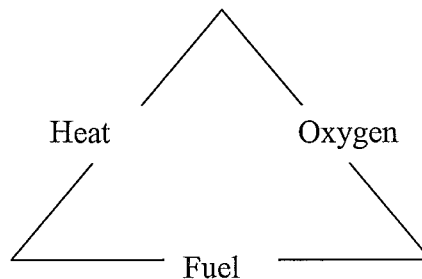


Figure 5.1 - The fire triangle

It is from this that the principal of fire extinguishment can occur. Removal of any one of these elements will lead to the removal of the fire.

Fires generally follow the same pattern. Each fire is unique and accordingly timescales and magnitudes will vary (Buchanan, 1994). Figure 5.2 is a typical fire development curve.

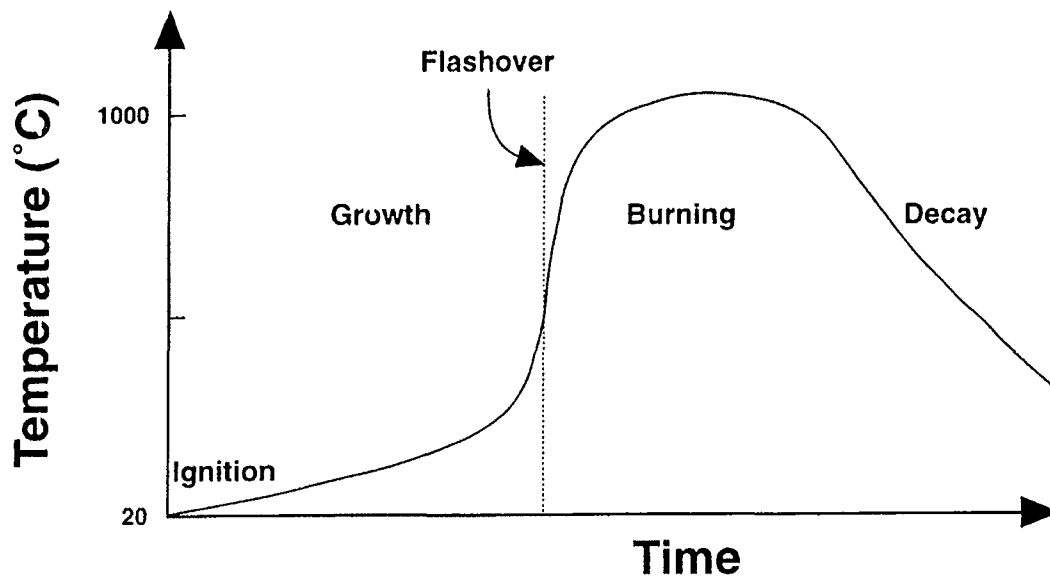


Figure 5.2- Fire development curve (from Buchanan, 1994)

Each fire will have a growth, burning and decay phase if left to burn. A fuel is assumed to have an increasing heat output according to a quadratic equation with time, the growth phase of a fire is an exponential curve. It is because of this relationship that the growth phase of a fire is critical. Flashover is when a room reaches a critical temperature and everything in it ignites. It is at this point that extensive damage occurs.

5.2 Reducing Fire Losses

Before fire can be extinguished it needs to be detected. In the case of schools the majority of fires happen during times when the property is vacated, at nights and weekends. This means that detection by the occupants is not possible. Systems need to be installed to automatically detect the presence of fire or smoke. Upon detection the fire then needs to be suppressed. The building should be provided with a safety system that provides fire

protection. This is available in both passive and active systems, and ideally a combination should be installed.

5.3 Passive systems

Passive fire protection is a type of protection that is a permanent part of a building. It is something that requires no action by anyone or anything in order for its functional use to be successful. For instance, fire resistant walls are a form of passive protection (Buchanan, 1999). The most important thing that could be added to new schools is to separate rooms into firecells with fire resistant walls. If installed properly, these will reduce damage by limiting any fire to the room of origin. It is essential that the fire resisting walls go up through the ceiling space to the roof, to prevent fire spread via the attic space.

5.4 Active systems

Active fire protection systems are those that require action. The best form of fire protection is an automatic sprinkler system. Other forms of active systems are smoke alarms, extinguishers, etc (Buchanan, 1999).

5.5 Sprinkler Systems

There are several ways a fire can be extinguished. Sprinklers use water as the medium to extinguish the fire. The actual mechanism that stops the fire could be either the cooling of the solid or liquid combustible, cooling of the flame, generation of steam to prevent oxygen entering the reaction zone, or a fog that blocks radiative heat transfer. Sprinklers intercept the fire early in the growth stage as in Figure 5.3, and cause the fire the decay and extinguish. This greatly reduces the damage that the fire causes.

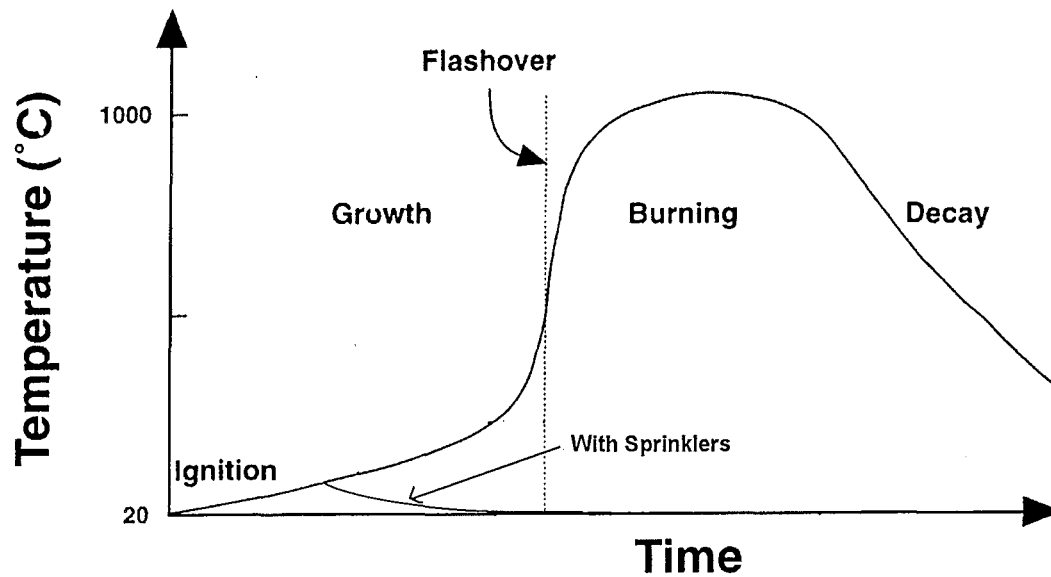


Figure 5.3- Fire development curve with sprinklers (modified from Buchanan 1994)

5.6 Security and Smoke Detection Alarm Systems

These dual alarm systems give early warning of fires. They do nothing to but alert people of the presence of smoke and flame. There is no mechanism that extinguishes the fire.

The fire will burn until it decays or until the Fire Service arrives and applies water on the fire. The fire has the potential without intervention to reach flashover and this is when the damage is really caused. Everything in a room is involved in the fire, it is oxygen derived and moves seeking oxygen causing rapid spread and growth. This situation should be avoided.

6. Security and Smoke Detector Alarm Systems

A combined security and smoke detector alarm system is currently being installed in schools around New Zealand. Approximately 900 schools have the system installed.

6.1 The security and smoke detector alarm system.

This section is based on personal communication with Mr Trevor Tozer, National Security Coordinator, Ministry of Education.

In 1990 the Ministry of Education began to act on the appalling statistics of the late 1980s. The statistics of the period of 1989/90 showed fire losses of \$23.4 million for New Zealand schools. Hon Phil Gough, the Minister of Education at the time requested a strategy be devised to correct this problem. Mr Trevor Tozer, a former policeman with 29 years experience, was employed to address the problem of school arson.

The statistics showed that 65-70% of arson fires were lit from inside the building. This led to the theory that arson was probably not the first intention of the offender, and was committed as an after-thought. It was proposed that installing security alarms could discourage the potential arsonist from entering the building and thus prevent the arson fires.

If an intruder enters the building an alarm is set off. A “painfully loud” siren will ensure the intruder will not stay in the building. As a fire prevention measure, smoke alarms are also included to act as an early warning to the presence of fire. The security and smoke detector alarms are linked to a control panel that is then in turn linked to a monitoring station (a security company). In the event that an intruder alarm is set off a security guard

is sent to the school. If a smoke alarm is activated the security firm rings 111, and alerts the Fire Service.

Since 1991 approximately 900 of the 2500 schools in New Zealand have had the dual alarm system installed. In the first six months of 1998, there were 27 school fires, according to the Ministry of Education. Twelve of these occurred in schools with the dual alarm system. All of these 12 fires were externally lit. Location and presence of these fires was recorded by the activation of the nearest smoke alarm to the fire, proving its use as an early warning device.

Mr Tozer considers the system to be a success and its adoption has become a national policy, with the Government spending \$2 million per year to protect schools with this system. The money is assigned to regions according to the number of fires experienced and then to schools within these regions that are considered to be of the highest risk.

Mr Tozer has produced a very thorough document that covers the exact requirements of systems installed into educational buildings (Ministry of Education, 1998).

6.2 Marsh and McLennan study - Fire Loss Report

A study is under way by Marsh and McLennan for the Ministry of Education to assess the cost effectiveness of the dual alarm systems. It runs for a year from the 1st July 1998 to the 30th June 1999, which corresponds with the Ministry of Education's financial year and the insurance year. Its purpose is to justify the expenditure on the dual alarm systems and to ensure that the system is doing what it is supposed to.

The study requires a form to be filled for every claim for fire losses exceeding \$500. The form (in appendix 2) asks questions regarding:

- the performance of the smoke/intruder alarm system, if one was installed
- the performance of the sprinkler system, if one was installed
- the cause of the fire, and how it was extinguished
- the cost to reinstate damaged property
- the type of building involved (eg. Administration block, gymnasium)
- whether the Fire Service attended, and whether it was the permanent force or a voluntary brigade
- the date and time of ignition
- the time the Fire Service were notified
- the time the Fire Service arrived

The results of the study will be available later in 1999. David Leather, from J & H Marsh and McLennan, predicts that the dual alarm systems will be proven to be a justifiable expenditure, since the early warning of any fire is expected to save the Ministry of Education money.

6.3 Specification Document for the Supply and Installation of Security and Smoke Detection Alarm Systems for the Ministry of Education.

The Ministry of Education has produced a document that specifies the requirements of the alarm systems installed in schools (Ministry of Education, 1998). The document is prescriptive and specifies the hardware that shall be used. It consists of two parts:

- Standard Conditions of Contract, and
- Specification for the Installation of an Alarm System.

6.3.1 The Security System

The specification requires:

- The alarm system to be set out exactly as in the document.
- If alternatives are considered then cost differences and technical details are to be submitted to the Ministry.
- Installers must be registered under the Private Investigators and Security Guards Act 1974
- The materials, apparatus, and workmanship shall comply with NZS4301:1993 “Intruder Alarm Systems”
- The existing control panel (if a system is being replaced) shall be removed and returned to the Ministry
- The system will be controlled by a Concept 2000/3000 or a Tecom Challenger control panel, with the system expanded to sufficient zones to comply with the specification
- The control panel will have an expanded memory chip, of a specific type
- Control panel detection zones shall control only one detector
- All isolating will be carried out at code pads, so that it is not possible to auto isolate
- Power supplies shall comply with NZS4301:1993
- Power supplies at each expander for internal sirens
- All detectors, control panels, and other equipment shall be fitted with anti tamper devices
- Passive Infra-red Detectors (PIR) types are specified
- PIRs to be installed where technically appropriate
- PIR chosen will allow for optimum coverage of room
- Cable entries are to be sealed with neutral silicone rubber
- Location of Magnetic Proximity Devices for particular doors and windows is specified

6.3.2 Smoke Detector Alarm System

The specification states that “for a ‘Property Protection’ system the requirements of NZS4512 (Fire Alarm Systems in Buildings) generally will be met, however the selection, spacing and quantities of the smoke detectors will be as per this specification and supplied drawings” (Ministry of Education, 1998).

In cases where a Fire Service approved system is to be installed it is required to comply fully with NZS4512. This is required in cases where compliance with the NZBC is required for life safety.

An annunciator panel is required to assist in locating the fire. The premises are divided into zones. Each zone will have one indicator on the panel for detectors and manual call points. The position shall suit Fire Service access and be clearly visible.

Each zone will have three LEDs:	red	system activated
	green	system normal
	yellow	system defect

Smoke detectors are to be based on the Detection Systems Model DS 250 Series with a MB4WE/ 4 wire power supervision base, or ESL model 449 CTE. They will be wired to enable monitoring of all functions.

The smoke detectors are to be positioned in the centre of any flat ceiling area. In the case of sloping ceilings they are to be positioned in an appropriate position within 500mm but not closer than 400mm to the apex of the roof. They shall not be vertically mounted or within 400mm of any wall, beam or other obstruction.

Smoke or thermal detectors in the same air space can be connected to the one zone.

Thermal detectors are to comply with NZS4512 with automatic resets and 57°C rating.

Power supply to the smoke detectors will be monitored by one power supervisory relay per detector, to ensure that in event of power supply failure a warning signal will be sent.

The audible alarm for the intruder system will be a P.S219 type Piezo Siren, colour white. It may not be mounted closer than 300mm to passive infrared detector. The audible alarm for the smoke detector system will be a standard type red plastic fire siren. It shall be mounted on the ceiling in the corner of room, facing 45° into room. All audible alarms are to be separate from school bells.

External sirens will comply with NZS4301. They will be stainless steel, double skinned and shall have tamper protection. The alarm will sound for 8-10 minutes. A blue strobe light will flash on activation and will continue after the alarm ceases to sound. In the event of activation of either the intruder or smoke alarm all sirens of that system will sound in all areas.

The rest of the specification details procedures for:

- remote monitoring
- mains supply
- building penetrations
- conduits, trunking and neatcap
- installation of cable and wiring
- marking
- testing inspection and commissioning
- documentation

The system is required to be fully tested, inspected and commissioned by the installer. A schedule is to be submitted for inspection. Commissioning is to be carried out by an independent commissioning inspector, as per the “Certification of Intruder Alarms” and the Code of Practice of Intruder Alarms.

6.4 About the security and smoke detection system

Personal communication with Mr Mike Kyne, a security management consultant from Kyne Security Management in Christchurch, indicates that the system specified in the Ministry document is a good system. The type of panel specified is the best available for the task. It is highly reliable and can deal with the task easily. However, the system is complex and needs to be installed by experienced workmen. Problems arise when work is given to the lowest tender and not necessarily to people qualified to do the job.

Mr Kyne believes that the decision to have a specification that does not comply with NZS4512 is intended to make these systems affordable for schools. The connection to the Fire Service costs approximately \$2500/yr whereas a connection to a security service costs the school approximately \$520/year. The solution is to provide the best possible protection affordable, even if the systems are not completely ideal. Mr Kyne would like to see completely protected schools but in his experience they do not have the money available.

6.5 International Experience

In a US study (Ahrens, 1997) it was found that in 1995, 65.9% of the structure fires in educational property had detectors present, but the detectors only operated in 79.7% of those fires. This illustrates a problem with the installation and upkeep of systems. To have a reliable system it needs to be regularly tested and maintained.

6.6 Comments

The security and smoke detection alarm system appears to be working. It has enables fires in schools to be noticed in their early stages where previously they would be large in size before notification could be made. The statistics shows that the cost involved with school fires in New Zealand have decreased since 1991 when installation began.

The problem with this system is that there is no action on the fire until the Fire Service arrives. It is this response time lag that leads to the prediction that the cost of school fires in New Zealand will not drop below some lower limit. This lower limit will be defined by the total cost of the damage sustained in each fire incident before the Fire Service response. If this value of losses is unacceptable, the only option is the installation of sprinkler systems.

The Ministry of Education is currently installing smoke and intruder alarm systems under the assumption that they will provide a high level of fire protection and significantly lower the cost of fire damage. Unfortunately these systems are expected to provide a level of protection that can only be offered by sprinkler systems.

7. Sprinkler Systems

7.1 How they work

Sprinkler systems consist of a system of pipes and sprinkler heads. The piping is suspended from the ceiling and charged with water. The sprinkler heads are heat operated valves that enable the fire to be automatically detected, an alarm given and water placed directly on to the fire (Buchanan, 1994).

The sprinkler head has an orifice that is held closed with a disk that is released upon a temperature sensitive device. The sprinkler head needs to be heated until its predetermined characteristic temperature and then the bulb will break and then the water will flow.

A fire produces heat and smoke that rise due to buoyancy effects. The heat and smoke will accumulate at the ceiling and once the temperature of the layer reaches the activation temperature of the sprinkler head then the sprinkler will activate. Sprinkler heads remote from the fire do not operate.

Sprinklers are an extremely effective form of fire protection. Water-cools the reaction zone. Water droplets interfere with the reaction and thus combustion is stopped, or at least greatly reduced so that the fire will not grow.

The water supply is required to be adequate for the expected maximum demand, to be protected from frost and to be reliable (Boyt, 1994). A main stop valve and an alarm valve control the water supply into the system. The stop valve is operated manually and is locked in the open position. The Fire Service can turn it off in situations when the

application of water is no longer required. The alarm valve is above the stop valve. It stops backflow of water and sets the alarm off once the water has begun to flow.

7.2 Fire Protection

Sprinkler systems are the most effective form of fire protection. They can detect a fire, send an alarm and extinguish the fire. They would be ideal for use in schools to lower the cost of fires, since the key to reducing the damage caused by fire is to attack it in the early stages.

7.3 New Zealand Policy

7.3.1 NZS4541

The New Zealand standards for sprinkler systems are NZS4541 (and NZS4515 for residential properties). Compared with overseas codes these are considered to be comprehensive and provide a very high level of fire protection. The key to this is that a high standard is required for installation, maintenance and testing.

7.3.2 Ministry of Education view

The Ministry of Education intends to install sprinklers in all new school buildings to standard required by the local Territorial Authority. This means that the system will comply with either NZS4541 (or NZS4515) or the New Zealand Building Code.

7.3.3 Legal requirement

If the Approved Documents to the New Zealand Building Code require the installation of a sprinkler system, it must be installed generally in accordance with NZS4541. There are minor differences between the Approved Documents and NZS4541.

If the owner of a building with a sprinkler system wishes to obtain acceptance of the system for insurance purposes, it is necessary to fully comply with NZS4541, and have the system approved by the Insurance Council, following the inspection by Fire Protection Inspection Service (FPIS).

Mr Russell Gregory, a special projects engineer at Wormalds with many years experience in the sprinkler industry believes that any sprinkler system installed should comply with a recognised sprinkler standard of some type. It is important to realise that once a sprinkler system is installed it must be on the Compliance Schedule of the building and must therefore be tested and maintained regularly.

The installation of any system into a building for the purposes of fire protection or warning of occupants of the presence of a fire requires the consent of the Territorial Authorities. They require any system to comply with the Building Act or NZS4541.

7.3.4 Partial sprinkler installation

Partial sprinkler installation is a very controversial subject. As is stated in the Fire Engineering Design Guide “the objective of design and installation of detection and suppression systems is to ensure that these active fire safety systems meet the performance requirements and will operate as intended to save lives” (Buchanan, 1994). Is it then appropriate to partially install protection systems in buildings and expect the same results as properly and fully installed systems?

A sprinkler system is designed based on the occupancy hazard of the room and that the sprinkler is activated by the fire during the early development stage . It is important to realise that sprinkler systems are not designed to cope with a developed fire entering the protected area (Boyt, 1994).

The opinion of Marryatt (1988) is that partial protection by sprinklers of a building is unsound. A sprinkler system is designed to control the fire at the origin. The damage to a building in the case of a fire will be much greater if the fire starts in an area that is unprotected. The entire system (and the point of installing the system) could be compromised. From the examples given in Marryatt (1988) partial protection by sprinklers in a building is not an option unless there is extremely good fire resistance between the sprinklered and unsprinklered parts of the building. It is generally considered important that a building is well compartmentalised and that each compartment is protected by the sprinkler system.

NZS4541 requires a 4-hour firebreak between sprinklered and unsprinklered parts of the same building. The New Zealand Building Code requires less stringent firebreaks.

It is often in fear of water damage that partial coverage by sprinkler systems is desired. An example would be to sprinkle a school but to not include the library, as water damage to all the books is a great fear. Marryatt showed that in cases where protection was removed or not installed for fear of water damage, the resulting damage from both the fire and water (from firemen's hoses) was much greater than would have been caused by a sprinkler system.

7.3.5 Trade offs

Trade offs are clauses in the Approved Documents of the Building Code that allow various reductions in passive protection, and extensions of escape route path lengths where an approved sprinkler system is present (Barnes, 1997).

This can mean that a building that requires a 30-minute passive fire protection rating could have it reduced to 15 minutes if sprinklers are installed in a system conforming to NZS4541. This could be a saving to the owner and also an incentive to put sprinklers into buildings.

There are also possible insurance premium reductions, although the insurance industry in New Zealand has not generally given significant reductions for the installation of sprinkler systems, despite the huge reduction in risk of property loss. It is important to remember that if a system is to be eligible for premium reductions then it must comply with NZS4541.

7.4 Performance

7.4.1 New Zealand

The statistics show that in New Zealand and Australia over the last 100 years that sprinklers have been in operation, 99.5% of fires in sprinklered buildings have been controlled by the sprinkler system (Marryatt, 1988). This is an impressive statistic and the exceptions have been explosions and flash fires, where the system is knocked out of service. New Zealand has sprinkler systems linked to the Fire Service and a strict sprinkler code, with a high standard of maintenance in comparison to some other countries.

One of the reasons for the success of New Zealand and Australia over other countries when it comes to sprinkler performance could be the very strict inspection and maintenance procedures that are required by NZS4541 and NZS4515 (Barnes, 1997).

7.4.2 Overseas

In a US study (Hall, 1996) it was found that sprinklers reduced the average fire loss. Table 3.8 is an abbreviated version from Hall (1996). It shows that in educational buildings the use of sprinklers reduced the cost of property damage by 67%. This study data was from average fire losses per fire in the United States using annual averages from 1985-1994. It is interesting to note that only the occupancies that were considered to make significant use of sprinklers were included in the table, schools were one of them. This shows a significant saving in fire losses, and it is interesting to note that educational properties had the highest reductions out of all property types.

In Britain, with the Building Regulations of 1992, allowances for trade offs between active and passive fire protection systems are possible in most types of non-residential buildings (Dowling et al, 1993). This is to encourage the use of sprinklers in buildings.

Roy Young of the Loss Prevention Council in England (Young, 1992) warns that only 70% of fire doors are closed in a fire, and that fires do spread from room of origin. His opinion is that sprinklers are simple, robust and effective - making them ideal for application in schools.

Don Powers is a fire consultant. His opinion on the installation of sprinklers in schools (Powers, 1995) is that in England public authorities are committed to reducing expenditure and that fire protection is last on the list of things to spend money on. However he points out that this is a self defeating situation as an investment in protection

systems could lead to saving of millions of pounds that could go into education rather than the rebuilding and repair of buildings.

David Leech, a Risk surveyor for Municipal Mutual Insurance, recommends for high risk schools a security package and in addition a system that will detect fire, extinguish or control fire and alert the Fire Service (Leech, 1992c). This can all be achieved only with a sprinkler system. This was never seen as a requirement for schools as they were never historically considered high risk, although they now are. Municipal Mutual Insurance gives reductions in insurance premiums for fire as long as the sprinkler systems are installed in accordance to the British standard BS5306 Part 2 and LPC technical bulletins.

7.5 Misconceptions/Cautions

A common misconception with sprinklers is that if the system is activated all the heads will go off, flooding all the rooms, and that the damage from the water will far exceed that from the fire. While the type of system where all the heads will go off (deluge) is available it is only used in extremely special occupancies such as aircraft hangers. Normal sprinklers are activated when the heat at each head reaches the activation temperature of 57°C or higher. Only the head that is activated will go off.

In Marryatt (1988), it was reported that 65% of fires featured the activation of one sprinkler head, while 35% of fires required the activation of two or more sprinkler heads.

It is commonly accepted in the field of fire protection that for a standard fire the amount of water that is required from a sprinkler to extinguish or control the fire is only about 10% or less of the water that the Fire Service would put on to the fire.

7.6 Conclusion

When sprinklers are installed in new schools the author recommends that the Ministry of Education seek the expertise of a fire engineer. The installation of sprinklers could possibly lead to the redundancy of other systems that are installed. For example if sprinklers are installed in some situations the smoke detection system may be redundant, that is if it is not required by the building code, as any fire attended will already be controlled by the sprinkler system.

If the purpose of installing fire protection into school buildings is to protect the school from the costs of fire, both direct and indirect, then the only solution is to install sprinklers.

8. Benefits and Costs of fire protection

The costs of fire protection vary depending on the level of protection that is required. A high level of fire protection is going to cost more than lower standards, or no fire protection at all. Similarly, as the level of fire protection is increased so is the level of benefits.

8.1 Direct Costs of fire

The direct costs of fire are more easily quantified than the indirect costs. The direct costs involve the replacement of the items that are destroyed by the fire. The cost of repairing the school is easily calculated, as are the replacement values of the core items in a classroom. These core items include desks, chairs, mats, blackboards, whiteboards etc.

Trevor Tozer, National Security Coordinator, uses the rough estimate that for every classroom destroyed it will cost \$100,000 to have it replaced and ready to use again. This includes the clean up of the site, architects, contractors and rebuilding.

8.2 Indirect Costs of fire

This section describes reports of three schools in Christchurch, which have experienced fires.

- Phillipstown school,
- Hammersley Park School, and
- Linwood Avenue school.

In all three cases there was severe damage and this is an account of the situation and the personal observations of the people involved.

A summary of the indirect costs are:

- loss of teaching materials,
- student records,
- artwork,
- written work,
- lost time,
- inconvenience of relocation,
- re-establishing the class room environment.

A survey on fires in low-rise industrial buildings in Holland shows an interesting statistical trend. That the indirect damage from a fire incident was approximately 20 % of the total damage incurred (Twilt et al, 1986).

Phillipstown School, 21 Nursery Road, Christchurch.

On the 5th December 1997 a 36 year old man committed arson and set fire to the school. It destroyed one classroom and severely damaged another. The Principal, Mr Lindsay Penman talked about the effects, indirect costs and comments that he had about the fire.

The school has 430 pupils and had a security alarm and smoke detectors installed. The alarm went off as the security firm was doing a routine check of the school. The guard caught the arsonist. The fire brigade was called and the security guards tried to fight the fire.

Mr Penman estimates that it took six months for the school to recover from the fire. There are a lot of additional costs and tasks involved with re-establishing after a school fire that are not always obvious:

- The loss of the teachers' personal resources, which may be an extensive of supply of information collected and produced during their career.
- Storage of property rescued from the fire.
- Time of teacher, principal and administration staff to source new teaching materials for rooms.
- A lot of teaching resources are difficult to find because they are unique and original.
- The emotional drain on the teacher and those involved.
- The teacher had to teach in the school hall, which was a poor teaching and learning environment.
- Insurance firms require meticulous and time consuming detailing of purchases and purchase costs.

Mr Penman would like to see teachers aides provided by the Ministry for schools that suffer fires to help with the teaching and running of the school while all the additional tasks are being dealt with. Overall the experience was extremely taxing to the staff emotionally and professionally.

Hammersley Park School, Quinns Road, Shirley, Christchurch.

On the 23rd of January 1994 some people illegally entered the special needs unit of the school. While using the kitchen they started a fire. The fire in the kitchen ignited curtains and spread into ceiling cavity. The building had no fire doors, smoke alarms, security alarms or sprinklers and it suffered extensive fire, smoke and water damage. The fire destroyed approximately half of the building.

The inability to use this unit was especially inconvenient as students with special needs had equipment custom made for their requirements. These students require more attention than the average student, since the majority cannot move or speak. The loss of equipment made it enormously difficult for teachers to teach and properly care for the children.

Records are particularly important when the child is disabled especially since many of them take medication. The records contain progress and testing that cannot be repeated. A lot of these records were lost.

The building was rebuilt with fire protection, fire doors and sprinklers.

Linwood Avenue school, Linwood Avenue, Christchurch.

The fire was at the beginning of the school year in 1996. One classroom was destroyed in a fire at night. The staff found out at 7 am about the fire and had to prepare for the children to turn up to school and find the result of the fire. A key part of the school environment is the creation of a safe and secure environment that is conducive to learning.

The fire destroyed this secure environment and it took many months to re-establish it. It took about six months until normality of the classroom environment and resources were returned.

Luckily the school had one spare classroom for the first half of the year. The teacher taught the affected class while other staff sourced resources. They believe that the time required to re-establish the classroom is a hidden and on going cost. The emotional trauma and management of the children was a huge burden on staff.

It was not only school resources but also a careers worth of personal resources that were destroyed. The whole school is now protected by smoke and security alarms.

8.3 Costs and Benefits of fire protection

There are three options for installing fire protection into schools. The installation of sprinklers, the security and smoke detection system, or the do nothing option.

8.3.1 Sprinkler system

The installation of sprinklers involves an initial capital cost as well as ongoing maintenance and testing costs. The benefits of installing sprinklers are that in the event of a fire the fire can be suppressed during the growth stage. The result will be minor fire damage in the room of origin. There will be smoke and water damage as well but this will be minor.

8.3.2 Security and smoke detection system

The cost of installing a smoke detector and intruder system is significantly cheaper than a sprinkler system. The benefits that are available are that when a fire starts the smoke detector will be activated. On the down side it is likely that by the time the Fire Service arrives, sets up, and fights the fire that a whole building could be affected by fire.

8.3.3 Nothing

There is no cost involved with installing no fire protection. Similarly, the benefits available are none. In the case of a fire, it can be expected that at least one or more buildings will be lost.

8.4 Techniques of cost benefit analysis

John Stephens (1995), of the LPC technical development group talks about the cost benefits of sprinkler protection.

For a sprinkler system to be selected using the cost benefit method the benefits should exceed the costs of installation and maintenance. Benefits are achieved when the installation of a system reduces the cost and/or the frequency of fire incidents. Benefits are the difference between the potential loss in an unsprinklered situation and the reduced loss due to sprinklers in another.

Any cost benefit analysis involves a requirement to estimate the rate that fire incidents occur and the average cost per incident. The annual loss is the estimated average cost of a serious fire incident divided by the mean time between serious fires.

The cost of installing a sprinkler system is mainly a single expenditure event and to compare with other events needs to be converted into an equivalent annual expenditure.

A balance sheet allows for ease in comparing the with and without system scenarios. It should include:

- Estimated Values- direct loss of buildings, direct loss contents, consequential losses, mean time between fires and average annual loss
- Capital Costs - Installation costs, financing charges, depreciation on capital sum, maintenance costs, sub total
- Annual Insurance Premium - buildings, contents, consequential loss, sub total
- Total Annual Net Benefit

Anything that could effect the costs involved in the scenario should be included in the balance sheet. Examples of situations that could effect the costs are:

- trade offs allowed by building code,

- insurance premium reductions
- consequential losses from pollution and the effect of an uncontrollable fire on the environment
- clean up costs

8.5 Comment

In cost benefit analysis indirect costs are usually not included, as they are difficult to estimate. From the schools studied for this report it is obvious that many hours of unpaid work and other costs were incurred due to the fire. If an estimate of indirect costs was included in future cost benefit analysis, the result may be the increase of expenditure on fire protection.

9. Case Study

The school chosen for the case study is Riccarton High School. The school consists of several Nelson Plan design buildings as well as some more modern buildings. The Nelson Plan Design is two storey weatherboard style building that are typical of a lot of New Zealand schools. They date back approximately 40 years. The school also has buildings under construction.

9.1 Specifications

9.1.1 Security and Smoke detection alarm system

The design of a dual alarm system into a school requires it to be installed according to the specification of the Ministry of Education.

9.1.2 Sprinkler System

A sprinkler system for Riccarton High School was designed to comply with the requirements of the sprinkler code NZS4541.

9.2 Cost Estimate

9.2.1 Security and Smoke detection alarm system

The school in question had a system installed last year. This system is currently being investigated, as it is not working satisfactorily. It is assumed that the company did not

comply with the Ministry of Education specification. Mike Kyne of Kyne Security Management in Christchurch is investigating the system.

Through personal communication with Mr Kyne a copy of the tender response range was received for the security and smoke alarm system installed in the school (found in Appendix 4). The tender values were:

Option 1	\$69,091.00 +GST
Option 2	\$52,722.00+GST
Option 3	\$51,179.00+GST

The system installed was the cheapest option, the lowest tender. Mr Kyne states that this system does not comply with the specification provided by the Ministry of Education for the supply and installation of security and smoke alarm systems in schools. From further discussions the tender option 2 of \$52,722+GST is the cost estimate that will be used for this case study. The tender documents indicate that this system does comply with the specifications and is likely to be a system suitable for use in a school.

9.2.2 Sprinkler system

Russell Gregory, a fire engineer at Wormalds, has produced a cost estimate for the full sprinklering of Riccarton High School in compliance with NZS4541 (in appendix 3).

Water supply for the sprinklers is assumed to be off the existing hydrant/water main which is fed from the Main South Road and Vicki St/ Curtletts Road. This supply main is assumed to be 100mm in diameter and capable of sufficient flow and pressures for both extra light hazard (ELH) and ordinary hazard; group 1 (OH1) occupancies. ELH is defined as non-industrial occupancy where the amount and combustibility of the contents is low. OH1 category includes industrial occupancies that handle, process or store

combustible material, it also includes places of public assembly. The hall, gymnasium and workshop areas are OH1, with the rest of the school ELH.

The cost estimate has been obtained by splitting the complex into four installations, each with separate control valves and separate connections to water main. This installation would cost \$231,000. If the number of valve sets used was reduced to two the cost could be reduced to \$215,000. If only one valve set was used the cost would be \$205,000. All the cost estimates are excluding GST.

9.3 Comparison of Benefits and Costs

The sprinkler system is the only type of fire protection that when installed will control the fire and minimise damage due to the fire. The cost of \$230,000+GST makes the sprinkler option reasonably costly.

The dual alarm system gives early warning of the presence of fire but fails to control the fire, at \$53,000+GST it is a relatively cheap option.

A possible scenario at Riccarton High School is a fire in the Nelson Plan Design building, block G/H. The building consists of 8 classrooms, a laboratory, resource rooms. The Nelson Plan design is a timber structure with weatherboard cladding. It is an old design with little fire protection or compartmentalisation. In a fire scenario it is expected to perform poorly.

In the situation when a sprinkler system is installed a fire is likely to damage the room of fire origin and cause minor smoke damage in the building. It is estimated that \$10,000 would cover clean up costs.

In the situation of a fire in a classroom that has fire resistant linings, the fire will be contained to one room. Using the Ministry of Education estimate of \$100,000 per classroom destroyed, it is then likely that the cost involved with recovering from the fire is \$100,000.

In the situation when a security and smoke detector alarm system is installed a fire is likely to damage many rooms. The fire will be able to grow and the damage is dependent on the response time of the Fire Service. The fire is likely to be left for 8 to 10 minutes before the Fire Service arrives and applies water to the fire. This could result in the destruction of many classrooms and extensive smoke damage. The water damage in this scenario is likely to be worse than in the previous scenario. At an estimate 4 to 6 classrooms could be destroyed. This would result in \$400,000 to \$600,000 to re-establish the school. It is highly likely that, given this expense, a building of this type would not be rebuilt but destroyed and replaced.

The end result is that automatic sprinkler systems are the most effective form of fire protection. If the motive behind installing fire protection into school buildings is to protect the school property, then sprinklers should be installed.

10. Conclusions

The conclusions drawn from this report are:

- Security and smoke detection alarm systems have been installed in New Zealand schools over the last 8 years.
- During this period there has been no significant change in the number of fires, however the cost of fires has reduced.
- Even though losses are down, fire still remains a serious problem, especially indirect costs, and loss of irreplaceable items.
- With a detection system but without an automatic sprinkler system any fire after hours is likely to destroy at least one room.
- Sprinklers are the only form of fire protection that will provide the high standard of property protection and further reduce fire losses.
- If automatic sprinkler systems are installed in accordance with NZS4541, then there is the potential for insurance premium savings.
- The best strategy to further reduce the cost of fire losses in New Zealand schools is to progressively install automatic sprinkler systems in new and existing buildings.

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Appendix 1 – Policy Statement

POLICY STATEMENT 1996/13: SPRINKLER SYSTEMS IN SCHOOLS

Sprinklers in Special Schools

Under Section 38 of the Building Act 1991 a territorial authority can decline to grant a building consent for the alteration of an existing building unless it is satisfied that after alteration the building will comply with the provisions of the Building Code for means of escape from fire.

The Building Code states that automatic fire suppression systems (sprinklers) shall be installed where people would otherwise be unlikely to reach a safe place due to confinement under institutional care because of mental or physical disability.

In effect, to meet the requirements of a building consent, when special school buildings are being altered, sprinklers are required to be installed.

Sprinklers in Residential Units at Schools

Sprinkler systems for residential units are also covered by the Building Code although there is no requirement or obligation for the Ministry under the Building Act 1991 to follow the Code for existing buildings.

However, if a building is being remodelled, the Ministry must follow the requirements of the Code in order to get a building consent. In terms of the code a sprinkler system is only required for a boarding facility or dormitory in special circumstances where:

- an upper floor with more than 60 beds has a configuration which allows smoke to spread from a lower floor;
- the highest floor level in a building is at least 25m in height and which was at least three or more floors.

Sprinklers in New Schools

New schools, including kura, are to be fitted with sprinklers as it is cost effective to provide them in situ rather than retrofitting and they provide an enhanced level of protection.

Sprinkler systems must be designed to a standard approved by the local territorial authority or a Building Certifier pursuant to Section 43 of the Building Act 1991 who will be responsible for the acceptance and issue of the necessary Certificate of Compliance. The system should be soundly based on either NZS 4515 or NZS 4541. In addition, appropriate guarantees should be obtained from the designer and installation contractor.

It is important that the Board of Trustees is aware of the proposed specification and accepts the consequent operating costs.

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Appendix 2 – Fire Loss Report Form

FIRE LOSS REPORT FORM

LOSSES EXCEEDING \$500		
1	Name and location of site	
2(a)	Was a combined monitored smoke/ intruder alarm system installed in the damaged facility?	
2(b)	If so, did it function?	
3(a)	Was a sprinkler system installed in the damaged facility?	
3(b)	If so, did it function?	
4	What was the cause of the fire?	
5	How was the fire extinguished? (e.g. extinguisher/hose reel or fire brigade using hose streams)	
6(a)	What was the cost to reinstate the damaged property?	
6(b)	or If not yet available, please provide a provisional estimate	delete one: Actual/Estimate
7	In what sort of building did the fire originate (i.e. classroom, gymnasium, administration block, for example)?	
8(a)	Did the Fire Service attend?	
8(b)	If so, was it a permanently manned or volunteer fire brigade?	
9	What was the estimated time and day of ignition (e.g. 17:00 hrs, Thursday 14/05/98)?	
10	At what time was the Fire Service notified?	
11	At what time did the Fire Service arrive on site?	

Appendix 3 – Sprinkler Quote

11-FEB-1999 14:13

WORMALD NZ CHCH



"PROTECTING PEOPLE & PROPERTY"

64 3 3654745 P.01/02
 Fire Equipment
 Sprinkler Installations
 Fire and Security Alarms
 Passive Fire Rating Systems

FACSIMILE TRANSMISSION

To: _____

Date: 10/2/99Fax No.: 364-2758Total Pages: 1 of 2 (including cover)Attention: RACHAEL CARTERFrom: RUSSELL GREENAttention Recipient:

This facsimile may contain privileged and/or confidential information and is intended only for the use of the addressee. If you are not the intended recipient of this facsimile you must not disseminate, copy or take action in reliance on it. If you have received this facsimile in error please notify us immediately. The confidential nature of and/or privilege in the documents transmitted is not waived or lost as a result of a mistake or error in transmission.

RE. RICCARTON HIGH SCHOOLSPRINKLER BUDGET FOR MASTERS PROJECTESTIMATED N° OF SPRINKLERS

<u>BLOCK A</u>	<u>HALL & OFFICES</u>	<u>GRD 120</u>	<u>150</u>
		<u>c/s 30</u>	
<u>BLOCK B</u>	<u>LIBRARY POTTERY RT</u>	<u>GRD 100</u>	<u>160</u>
		<u>c/s 60</u>	
<u>BLOCK C</u>	<u>SCIENCE HOME EC</u>	<u>GRD 60</u>	<u>105</u>
		<u>c/s 45</u>	
<u>BLOCK D</u>	<u>WORKSHOPS, LABS</u>	<u>GRD 90</u>	<u>140</u>
		<u>c/s 50</u>	
<u>BLOCK E/F</u>	<u>TWO STOREYED WITH STAIRS ADD</u>	<u>GRD 90</u>	<u>180</u>
		<u>FIRST 45</u>	
		<u>c/s 45</u>	
<u>BLOCK G/H</u>	<u>TWO STOREYED</u>	<u>GRD 60</u>	<u>145</u>
		<u>FIRST 45</u>	
		<u>c/s 40</u>	
<u>MUSIC, PROF. ARTS</u>		<u>GRD 85</u>	<u>125</u>
		<u>c/s 40</u>	
<u>GYMNASIUM</u>		<u>GRD 55</u>	<u>65</u>
		<u>c/s 10</u>	
		<u>TOTAL</u>	<u>1070</u>

11-FEB-1999 14:14

WORMALD NZ CHCH



"PROTECTING PEOPLE & PROPERTY"

64 3 3654745 P.02/02

Fire Equipment
Sprinkler Installations
Fire and Security Alarms
Passive Fire Rating Systems

FACSIMILE TRANSMISSION

To: _____

Date: _____

Fax No.: _____

Total Pages: 2/2 (including cover)

Attention: _____

From: _____

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RICC. HIGH SCHCONT'D

WATER SUPPLY FOR SPRINKLERS WOULD BE OFF EXISTING HYDRANT/WATER MAIN WHICH IS FED FROM MAIN SOUTH ROAD AND VICKI ST/CHARLOTTE RD, ASSUMED THAT SUPPLY MAIN IS 100MM AND CAPABLE OF SUFFICIENT FLOW AND PRESSURE FOR ELH, AND OH1 OCCUPANCY. THE HALL, GYMNASIUM AND WORKSHOP AREAS WOULD BE OH1. THE BEST PLAN

THE COMPLEX COULD BE SPLIT INTO FOUR INSTALLATIONS WITH SEPARATE CONTROL VALVES FOR EACH AND SEPARATE CONNECTION TO WATER MAIN

INSTALLATION 1	BUS B+D	300 HEADS	63,000-
" 2	" A + G/H	295 HEADS	62,000-
" 3	" E/F + GYM	245 HEADS	54,000-
" 4	" C + PERE ARTS	230 HEADS	52,000-
		1070	\$231,000-

ex GST

IF TWO SETS OF VALVES USED

i.e. INST 1 BC,D, + PERE ARTS, INST 2 A, G/H, E/F, GYM

TAKEN OVERALL COST WOULD BE APPROX \$215,000- ex GST

IF ONE SET OF VALVES FOR THE OVERALL, COST OF APPROX \$205,000 ex GST

TRUST THIS IS OF ASSISTANCE.

Russell
Russell

Appendix 4 – Security and Smoke Detection Alarm Prices

FIRE ENGINEERING RESEARCH REPORTS

95/1	Full Residential Scale Backdraft	I B Bolliger
95/2	A Study of Full Scale Room Fire Experiments	P A Enright
95/3	Design of Load-bearing Light Steel Frame Walls for Fire Resistance	J T Gerlich
95/4	Full Scale Limited Ventilation Fire Experiments	D J Millar
95/5	An Analysis of Domestic Sprinkler Systems for Use in New Zealand	F Rahmanian
96/1	The Influence of Non-Uniform Electric Fields on Combustion Processes	M A Belsham
96/2	Mixing in Fire Induced Doorway Flows	J M Clements
96/3	Fire Design of Single Storey Industrial Buildings	B W Cosgrove
96/4	Modelling Smoke Flow Using Computational Fluid Dynamics	T N Kardos
96/5	Under-Ventilated Compartment Fires - A Precursor to Smoke Explosions	A R Parkes
96/6	An Investigation of the Effects of Sprinklers on Compartment Fires	M W Radford
97/1	Sprinkler Trade Off Clauses in the Approved Documents	G J Barnes
97/2	Risk Ranking of Buildings for Life Safety	J W Boyes
97/3	Improving the Waking Effectiveness of Fire Alarms in Residential Areas	T Grace
97/4	Study of Evacuation Movement through Different Building Components	P Holmberg
97/5	Domestic Fire Hazard in New Zealand	KDJ Irwin
97/6	An Appraisal of Existing Room-Corner Fire Models	D C Robertson
97/7	Fire Resistance of Light Timber Framed Walls and Floors	G C Thomas
97/8	Uncertainty Analysis of Zone Fire Models	A M Walker
97/9	New Zealand Building Regulations Five Years Later	T M Pastore
98/1	The Impact of Post-Earthquake Fire on the Built Urban Environment	R Botting
98/2	Full Scale Testing of Fire Suppression Agents on Unshielded Fires	M J Dunn
98/3	Full Scale Testing of Fire Suppression Agents on Shielded Fires	N Gravestock
98/4	Predicting Ignition Time Under Transient Heat Flux Using Results from Constant Flux Experiments	A Henderson
98/5	Comparison Studies of Zone and CFD Fire Simulations	A Lovatt
98/6	Bench Scale Testing of Light Timber Frame Walls	P Olsson
98/7	Exploratory Salt Water Experiments of Balcony Spill Plume Using Laser Induced Fluorescence Technique	E Y Yii
99/1	Fire Safety and Security in Schools	R A Carter
99/2	A Review of the Building Separation Requirements of the New Zealand Building Code Acceptable Solutions	J M Clarke
99/3	Effect of Safety Factors in Timed Human Egress Simulations	K M Crawford
99/4	Fire Response of HVAC Systems in Multistorey Buildings: An Examination of the NZBC Acceptable Solutions	M Dixon
99/5	The Effectiveness of the Domestic Smoke Alarm Signal	C Duncan

99/6	Post-flashover Design Fires	R Feasey
99/7	An Analysis of Furniture Heat Release Rates by the Nordtest	J Firestone
99/8	Design for Escape from Fire	I J Garrett
99/9	Class A Foam Water Sprinkler Systems	D B Hipkins
99/10	Review of the New Zealand Standard for Concrete Structures (NZS 3101) for High Strength and Lightweight Concrete Exposed to Fire	M J Inwood
99/11	Simple Empirical Method for Load-Bearing Light Timber Framed Walls at Elevated Temperatures	K H Liew
99/12	An Analytical Model for Vertical Flame Spread on Solids: An Initial Investigation	G A North
99/13	Should Bedroom Doors be Open or Closed While People are Sleeping? - A Probabilistic Risk Assessment	D L Palmer
99/14	Peoples Awareness of Fire	S J Rusbridge
99/15	Smoke Explosions	B J Sutherland
99/16	Reliability of Structural Fire Design	JKS Wong

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